Data Communications Program

Avionics Discussion

Data Communications is a key element of the transition from the current analog voice-only air-to-ground communications system to a system in which digital communications becomes an alternate and eventually predominant mode of communication. In order to satisfy this concept in an affordable and operationally effective way, existing aircraft (e.g. equipage and underlying standards) must be provided with service where it makes sense, while still moving toward equipment which will enable the Next Generation Air Transportation System (NextGen) and Single European Sky ATM Research (SESAR) concepts.

Given the heterogeneous nature of the US aircraft fleet, avionics upgrades will be required. These avionics upgrades include installation of VDL-2 capable radios, supporting avionics infrastructure, and data communications software applications.

DATA COMMUNICATIONS AVIONICS COMPONENT OVERVIEW

A range of avionics hardware components, software, installation kits, and installation labor are needed to enable the access of data communications air traffic services. The key hardware components are illustrated in Figure 1 below.

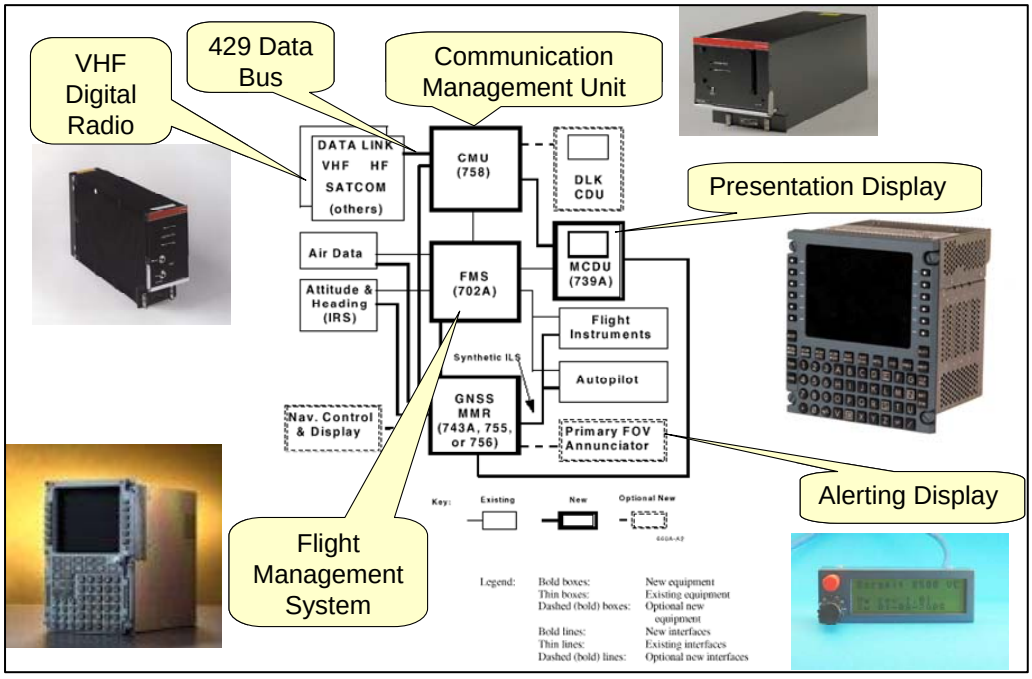

Figure 1 – Key Data Communications-related Avionics Components

These key data communications avionics components are characterized based upon standards published by the Airline Electrical and Electronic Committee (AEEC). The basic avionics com-

ponents are described in Table 1.

Table 1 – Description of Data Communication-related Avionics Components

Line Replaceable Unit	Description [3]
VHF Data Radio (VDR) [ARINC 750]	The VHF transceiver is capable of voice and data communications. The VHF transceiver supports, 8.33 kHz AM and 25 kHz AM voice, and VDL Mode-2 (31.5 kbps) data link communications as defined by ICAO.
Data Bus [ARINC 429W]	ARINC 429W is the predominant avionics data bus supporting the physical and electrical interfaces for the digital information transfer system.
Displays	Alerting and presentation of data communication messages necessitates a 429W interface between the CMU and aircraft-specific displays.
Communications Management Unit (CMU) [ARINC 758]	The CMU Mark 2 is used to route digital data link messages. The CMU Mark 2 is a tri-lingual device capable of ACARS communication, ARINC 622 data link communications and is capable of being expanded to provide Aeronautical Telecommunications Network (ATN) services.
Flight Management System (FMS) [ARINC 702A]	The Advanced FMS provides expanded functions beyond that defined in ARINC 702 to support the anticipated requirements for operation in the CNS/ATM operating environment. GNSS and RNP based navigation, air-to-ground data link for communications and surveillance, and the associated crew interface control/display definitions are included.

DATA COMMUNICATIONS AIRCRAFT HARDWARE CONFIGURATIONS

The U.S. domestic aircraft fleet is composed of a wide array of aircraft types and configurations. Even for a given aircraft model, specific avionics configurations vary across the fleet. Below are two generalized target data communications hardware configurations that could meet requirements for data communications services. Note that the specific data communications applications which provide the services are discussed separately from the avionics hardware configurations.

Configuration I - no FMS integration/autoload: In general, this configuration includes aircraft that have an ARINC 758-1 Mark 2 CMU, an ARINC 429W data bus, and at least one VDL Mode-2 digital radio (there could be up to three). This configuration may or may not have an FMS. The data communications applications are hosted in the Communications Management Unit (CMU), so there is no FMS integration/autoload capability for this configuration. Some representative candidate examples of this are the following: B-737-600, A-320, B-767-100, A-

340, CRJ-900, ERJ-190, and ATR72. This configuration is the baseline for Link 2000+ avionics.

Configuration II - FMS integration/autoload: This configuration includes the same ARINC 758-1 Mark 2 CMU, an ARINC 429W data bus, and at least one VDL Mode-2 digital radio (there could be up to three) as in Configuration I. It also includes the capability to autoload a data communications message into the FMS (for manual execution by the pilot). FMS integration/autoload is accomplished architecturally by the applications being hosted in the FMS (such as in existing FANS-1/A+ and FANS-2/B aircraft). This could also be accomplished for aircraft with CMU based applications by the addition of a logical connection between the CMU and FMS as defined in ARINC 656. It is important to note that ARINC 656 has not yet been implemented in production avionics. Existing FANS-1/A+ aircraft meeting interoperability requirements (e.g. DO-305, Future Air Navigation System 1/A (FANS-1/A) - Aeronautical Telecommunications Network (ATN) Interoperability Standard) as well as planned FANS-2/B aircraft are expected to fall within this hardware configuration.

DATA COMMUNICATIONS AIRCRAFT APPLICATION SOFTWARE CONFIGURATIONS

It is recognized that there are planned commercial offerings in response to the Link 2000+ implementing rule in Europe. Both avionics hardware configurations identified above support the minimum Link 2000+ requirements. In terms of the application software, Link 2000+ is implementing the set of services (ACM, AMC, ACL, and DLIC), and the associated message set as defined in the European Implementing Rule. In addition to Link 2000+, RTCA DO-280B is an existing standard that was produced by a joint RTCA EUROCAE group. Finally, as discussed in the RFC, the joint RTCA SC-214/EUROCAE WG-78 activity is in the process of defining the data communications safety, performance and interoperability requirements for NextGen/SESAR Initiatives beyond the Link 2000+ capabilities. Table 2 lists the different service/message set definitions.

Table 2 – Data Communications Implementation Definitions and Services

Implementation Definition	Data Communications Services (provided by the Data Communication applications)	Notes (note message counts include uplink, downlink, and system messages)
Link 2000+ Implementing Rule	Data Link Initial Contact (DLIC) ATC Clearances (ACL) ATC Communication Management (ACM) ATC Microphone Check Service (AMC)	Existing standard Compatible with Configuration I and II aircraft ~89 +/- messages total FANS-1/A+ interoperable

Implementation Definition	Data Communications Services (provided by the Data Communication applications)	Notes (note message counts include uplink, downlink, and system messages)
DO-280B	Data Link Initial Contact (DLIC) ATC Clearances (ACL) ATC Communication Management (ACM) ATC Microphone Check Service (AMC) Data Link Automatic Terminal Information Service (D-ATIS) Departure Clearance (DCL)	Existing standard Compatible with Configuration I and II aircraft Includes 23 messages not in Link 2000+ Implementing Rule (~112 +/-) FANS-1/A+ interoperable
SC-214 / WG-78 Work Package 1	Data Link Initial Contact (DLIC) ATC Clearances (ACL) ATC Communication Management (ACM) ATC Microphone Check Service (AMC) Operational Terminal Information (D-OTIS) Departure Clearance (DCL) Digital Taxi Clearance (D-TAXI)	Validation planned 2009 & 2010, completion planned for 2011 Compatible with Configuration I and II aircraft Includes all messages (~336 +/-) FANS-1/A+ interoperable
SC-214 / WG-78 Work Package 2	Data Link Initial Contact (DLIC) ATC Clearances (ACL) ATC Communication Management (ACM) ATC Microphone Check Service (AMC) Operational Terminal Information (D-OTIS) Departure Clearance (DCL) Digital Taxi Clearance (D-TAXI) Conformance Management/Flight Plan Intent (FLIPINT) using ADS-C 4D Trajectory Management (4DTRAD)	Validation planned 2009 & 2010, completion planned for 2011 Requires Configuration II aircraft Work Package 1 plus FLIPINT and 4DTRAD which require FMS auto-load/integration

The services included in Link 2000+, RTCA DO-280B, and SC-214 / WG-78 Work Package 1

do not require FMS integration/autoload and will work with both Configuration I and II aircraft. SC-214/WG-78 Work Package 2 requires the FMS integration/autoload capability and are therefore Configuration II aircraft.

It is recognized that there is a significant number of Configuration I aircraft for which operators may want to avoid the cost of an FMS installation, upgrade, or replacement. An example of this is an existing aircraft for which the operator would want to derive basic data communications benefits, while not wanting to bear the cost of an FMS upgrade or replacement due to age or cockpit hardware/software limitations.

As the FAA introduces data communications into the NAS, aircraft with both avionics hardware Configurations I (no FMS integration/autoload) and II (with FMS integration/autoload) may be provided data communications services. Each of these has different implications in terms of the services and message sets as indicated in Table 2. In addition, the ability of the controller/automation to differentiate these aircraft and provide the cognizant level of service is an issue to be resolved.

Consistent with the NextGen concept, the ability for the aircraft FMS and the ground automation to exchange data is the goal for the program in terms of long term avionics implementations. For example, the ability to transmit complex trajectory information from the ground to the aircraft and have it autoloaded into the FMS (for pilot execution) is the goal for all aircraft that would participate in Performance Based Operations. Configuration II aircraft with SC-214 Work Package 2 applications are required for this capability.

On the path to the NextGen implementation, all data communications equipped aircraft would be able to derive basic data communications benefits from data communications frequency changes, altitudes, headings, speeds, pilot requests, and simple route clearances. Additionally, Configuration II aircraft with SC-214 Work Package 2 applications would be able to gain benefits from complex route clearances and/or trajectories due to the FMS integration/autoload capability.

The FAA's goal in implementing data communications is to establish the infrastructure, take advantage of existing equipage where it makes sense, while encouraging convergence on a common set of applications/messages that will support NextGen and is in accordance with the U.S. agreed support to the ICAO Harmonization Strategy to stop partial implementation of Data Communications services i.e., message sets. In light of this discussion the Program is seeking comments on utilizing different implementation definition / standards (including combinations thereof) over the life of the program. Discussion of advantages, disadvantages, timing aspects, and risks is sought.